9.0 HYBRID INERT GAS GENERATING SYSTEM

The team has developed two hybrid concepts, each concentrating on reducing the major constraint to the size of the OBGIS and the OBIGGS. The hybrid OBGIS assumes that the baseline OBGIS would operate during taxi-in to the gate and while at the gate. The hybrid OBIGGS assumes the baseline OBIGGS is sized for all operations except descent. Both these systems offer reductions in flammability exposure similar or superior to that of the GBIS.

The average taxi-in time was determined to be 5 min. This adds 25% more time to inert for the small transport (which has the shortest gate time at 20 min) and 8% more time to the large transport (gate time of 60 min). However, this additional gate time does not reduce the weight, volume, power required, or cost of the OBGIS hybrid significantly from that of the baseline OBGIS.

The hybrid OBIGGS managed a more substantial improvement, reducing the weight, volume, power required, and cost by 25% to 70% compared with that of full OBIGGS. Ultimately, the overall cost of the system is still many times that of any potential benefit.

9.1 SYSTEM REQUIREMENTS

The Tasking Statement requires that the hybrid system be operated during some phases of flight as an option to installing equipment that might otherwise be necessary to keep the fuel tank inert during those phases of flight (e.g., vent system valves), and as a cost tradeoff that could result in reduced equipment size.

The Tasking Statement also requires that the team describe secondary effects of the system and analyze and report extracted engine power, engine bleed air supply, maintenance impacts, airplane operational performance detriments, and dispatch reliability.

The team must also provide information and guidance for the analysis and testing that will be conducted to certify the system.

If the FTIHWG cannot recommend a system, then all technical limitations must be identified and an estimate of the type of concept improvement that would be required to make it practical in the future must be provided.

9.2 CONCEPT DESCRIPTION

The hybrid OBGIS is schematically identical to the full OBGIS. It would be slightly smaller than the full OBGIS and would have to be certified not to interfere with other airplane equipment because it would be running during taxi-in.

The hybrid OBIGGS is simpler than full OBIGGS because it provides a constant flow of NEA to the fuel tanks, whereas full OBIGGS has a variable flow scheme.

9.3 APPLICABILITY OF CONCEPT TO STUDY-CATEGORY AIRPLANES

The OBGIS hybrid is applicable to the same in-service and production airplanes as the full OBGIS.

The hybrid OBIGGS is applicable to all the airplanes in the study category. There is insufficient information to determine whether the airplanes can meet the electrical demand of the system. Preliminary estimates by the Airplane Operation and Maintenance Task Team indicate that this system may exceed available electrical power.

An inerting system can be designed into future airplanes, provided the system size is calculated before engine, APU, and electrical generator selection. This will ensure that bleed air or electrical power is available.

9.4 AIRPORT RESOURCES REQUIRED

Powering the hybrid OBGIS requires electrical power from the airplane APU. Some airports are sensitive to noise and do not permit APU operation, requiring a ground power source to supply the system.

Hybrid OBIGGS is a self-contained system that does not normally require any airport resources. Some operators, however, may prefer using ground electrical power to operate the system after tank maintenance and inert the fuel tanks before the next flight.

9.5 AIRLINE OPERATIONS AND MAINTENANCE IMPACT

From an airplane operations and maintenance perspective, there is very little difference between the full OBGIS and OBIGGS and their hybrid systems. The Airplane Operation and Maintenance Task Team looked at the hybrid systems, but when it was determined that these systems were nearly identical from an operational and maintenance perspective, further work was discontinued. The reader may assume that the maintenance, operations, and modifications impact described in the OBGI and OBIGGS sections also apply to the hybrid systems.

9.6 SAFETY ASSESSMENT

Figures 9-1 and 9-2 show the impact that the hybrid OBIGGS could have on reducing future accidents in the United States and worldwide, respectively. If selected, the forecast assumes the system will be fully implemented by the year 2015. At that time, the forecast indicates the time between accidents in the United States would be 16 years with SFAR alone, 40 years with SFAR and inerting heated CWTs, and 48 years for SFAR and inerting all tanks. The corresponding time between accidents for the worldwide fleet would be approximately half that estimated for the U.S. fleet.

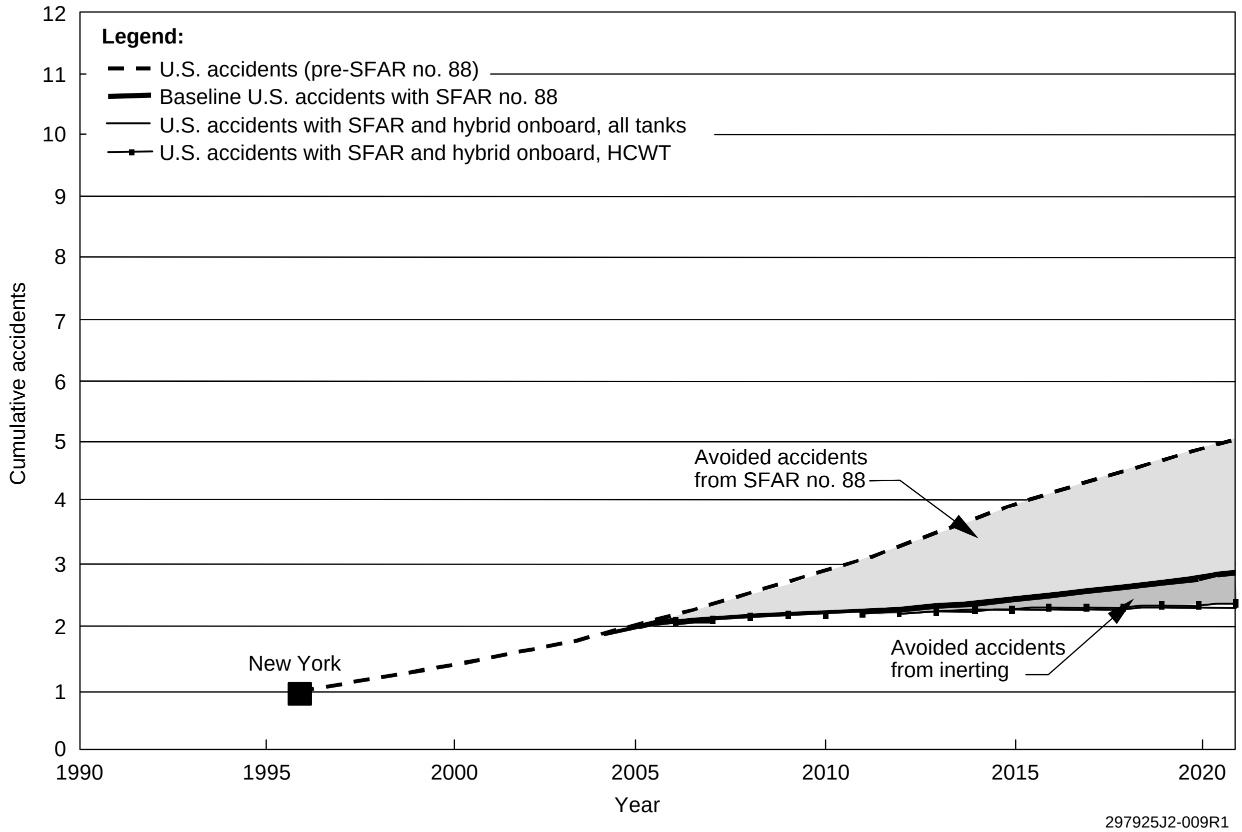

Figure 9-1. U.S. Cumulative Accidents With Hybrid OBIGGS

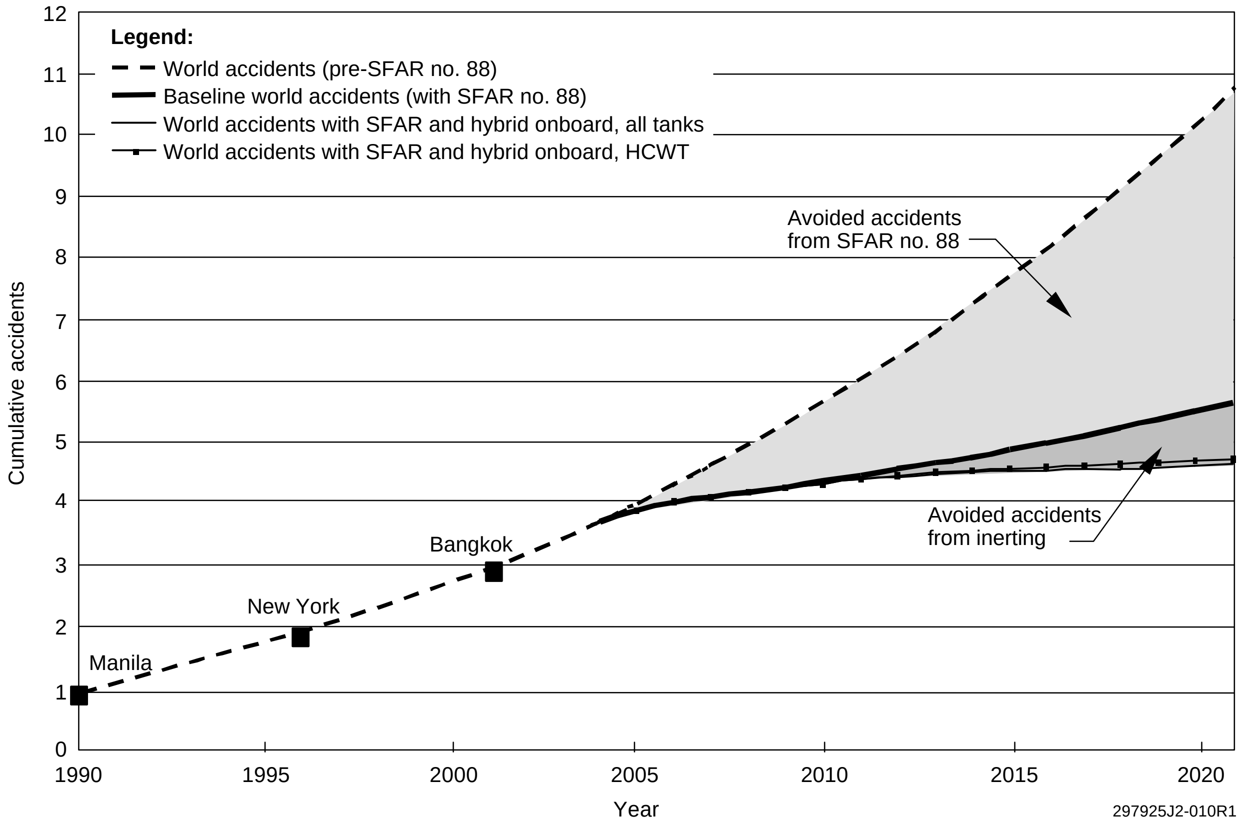

Figure 9-2. Worldwide Cumulative Accidents With Hybrid OBIGGS

Figures 9-3 and 9-4 show the impact that the hybrid OBGIS could have on reducing future accidents in the United States and worldwide, respectively. If the hybrid OBGIS were selected, the forecast assumes this system will be fully implemented by 2015. At that time, the forecast anticipates a time between accidents in the United States of 16 years with the SFAR alone, 31 years with the SFAR and hybrid OBGI inerting of heated CWTs, and 32 years with the SFAR and hybrid OBGI inerting of all fuselage tanks.

Corresponding times between accidents for the worldwide fleet would be approximately half those forecast above for the U.S. fleet, or about 8, 15, and 16 years, respectively.

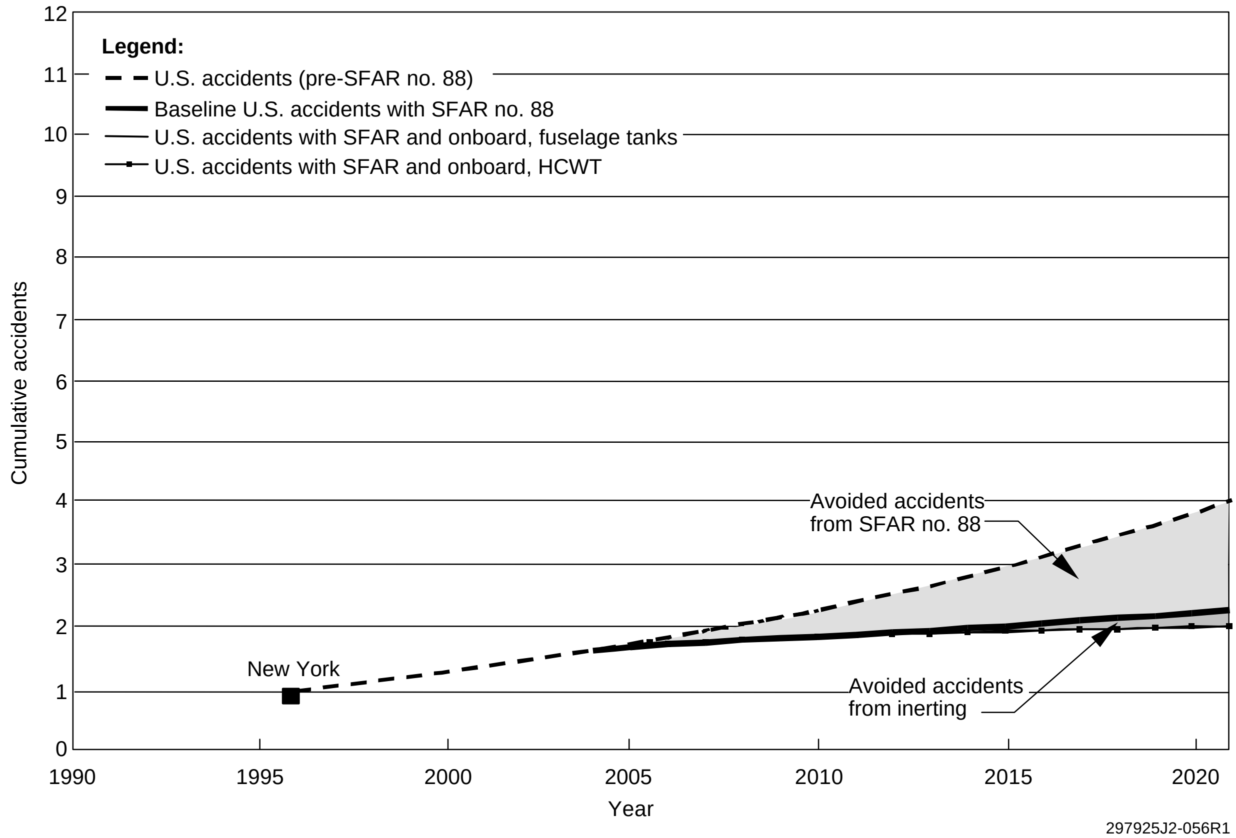

Figure 9-3. U.S. Forecast Cumulative Accidents With Hybrid OBGIS

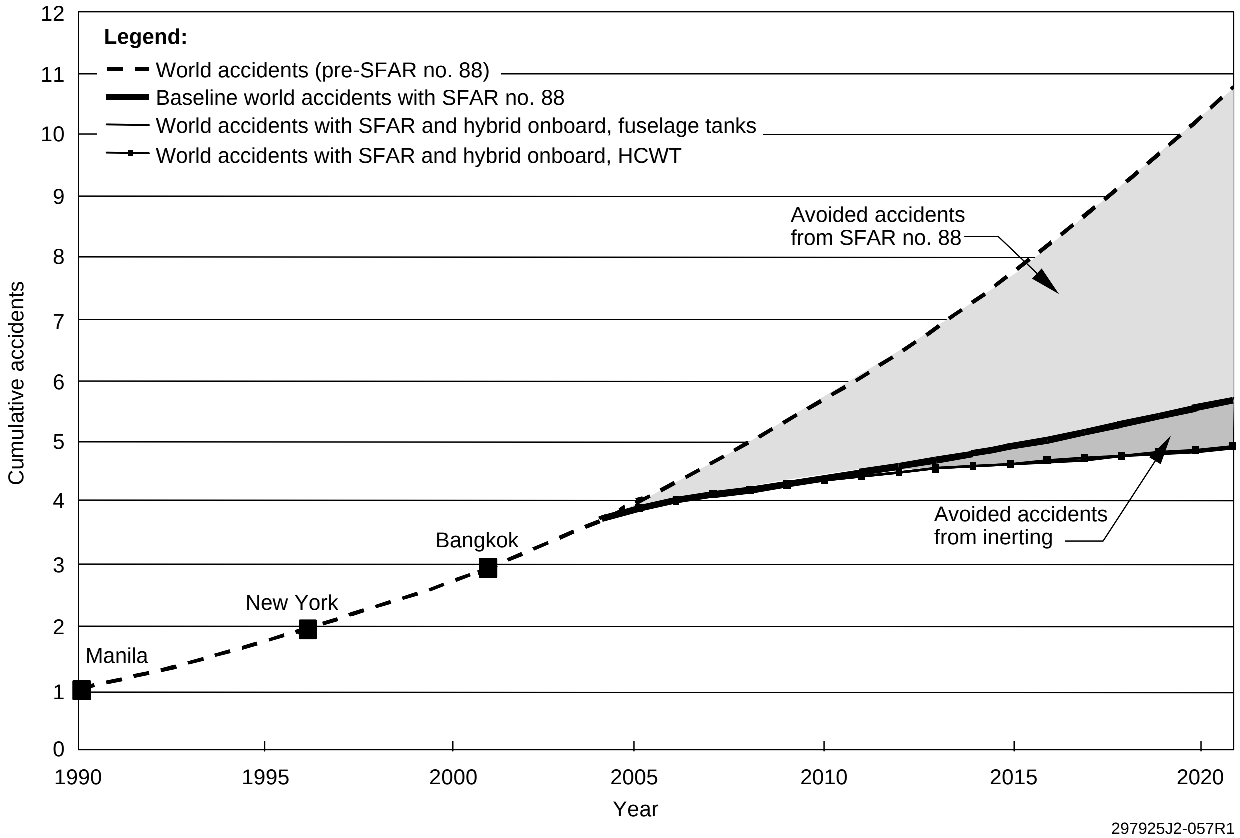

Figure 9-4. World Forecast Cumulative Accidents With Hybrid OBGIS

9.7 COST-BENEFIT ANALYSIS

Figures 9-5 through 9-29 graphically represent the cost-benefit analyses of the scenario combination examined for the hybrid inert gas generating system concept.

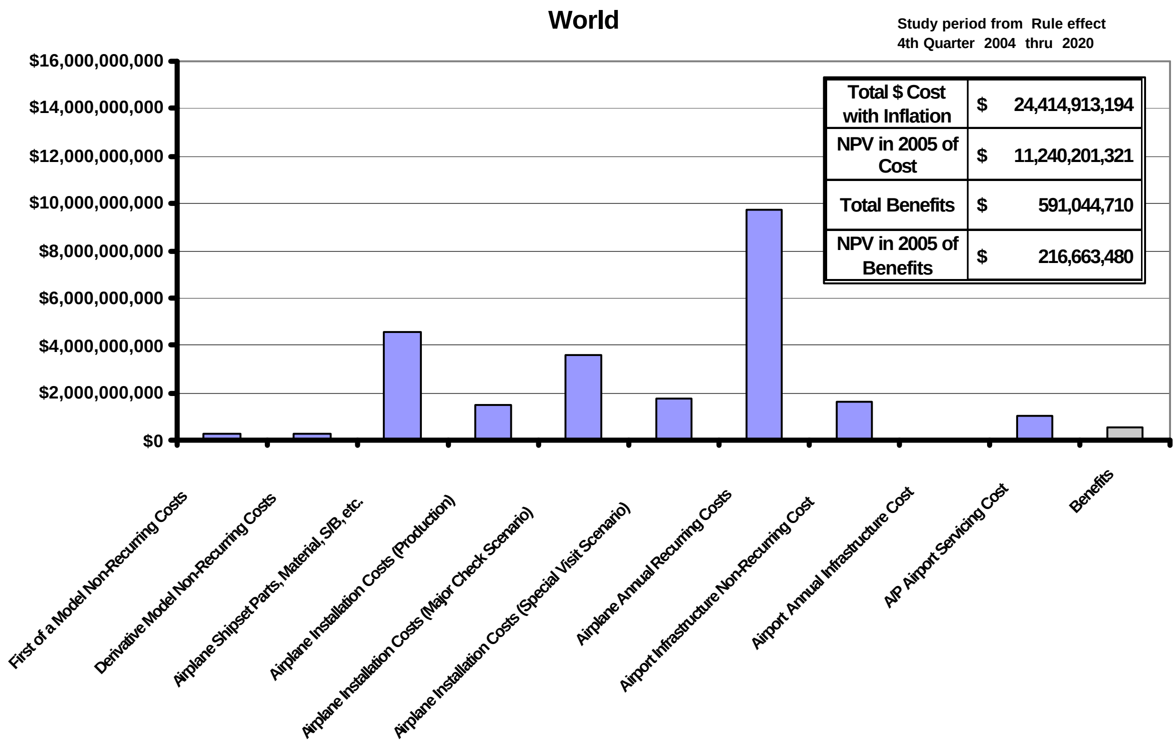

Figure 9-5. Scenario 3—Hybrid OBGI, Heated CWT Only, Large, Medium, Small Transports, PSA/Membrane Systems (World)

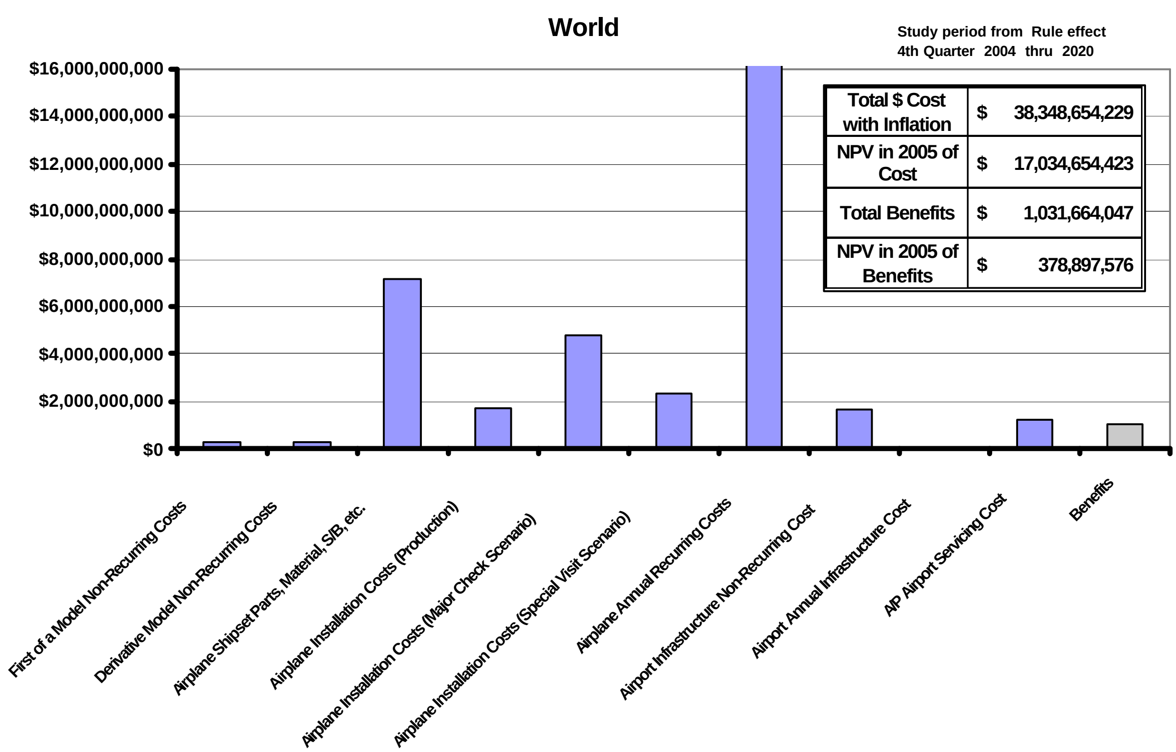

Figure 9-6. Scenario 4—Hybrid OBGI, All Fuselage Tanks, Large, Medium, Small Transports, PSA/Membrane Systems (World)

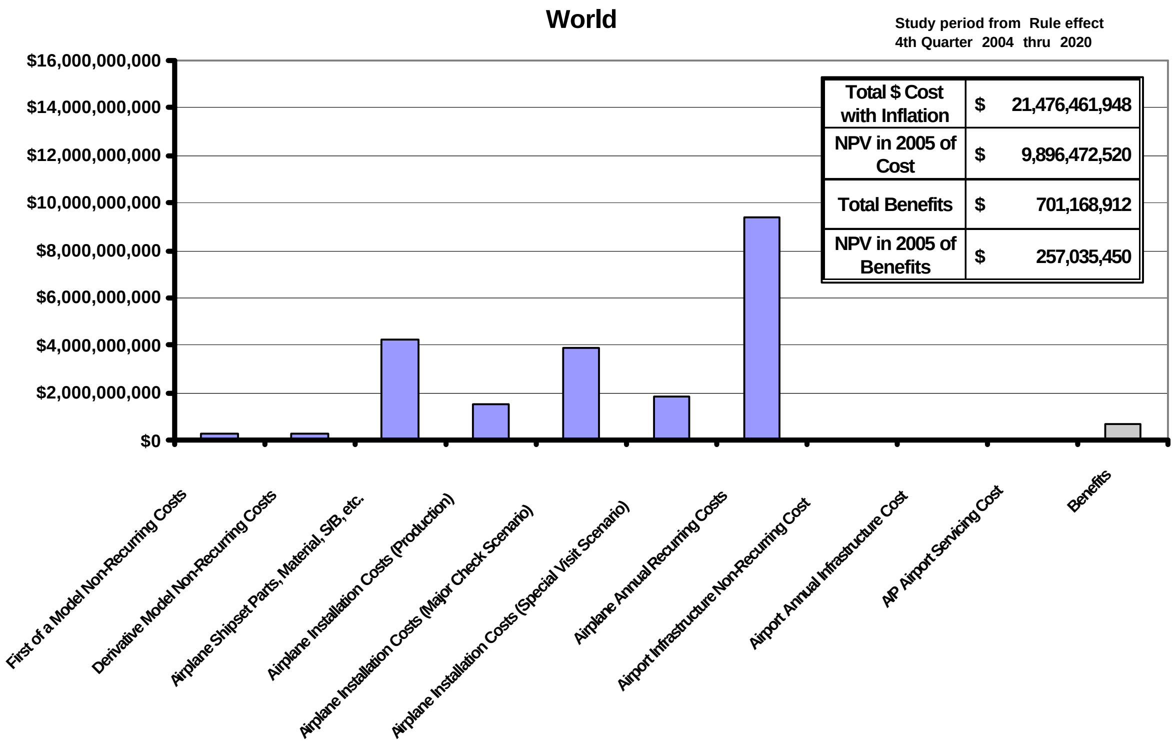

Figure 9-7. Scenario 7—Hybrid OBIGGS, Heated CWT Only, Large and Medium Transports, Membrane Systems, and Small Transports, PSA/Membrane Systems (World)

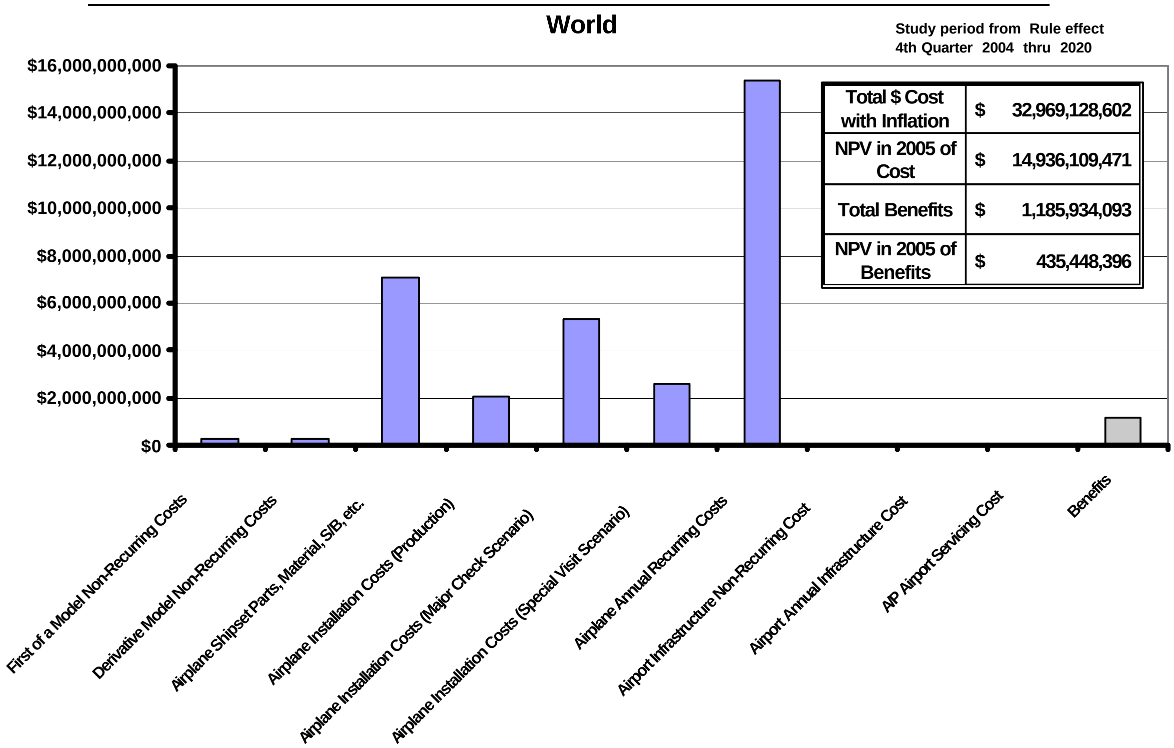

Figure 9-8. Scenario 9—Hybrid OBIGGS, All Tanks, Large and Medium Transports, Membrane Systems, and Small Transports, PSA/Membrane Systems (World)

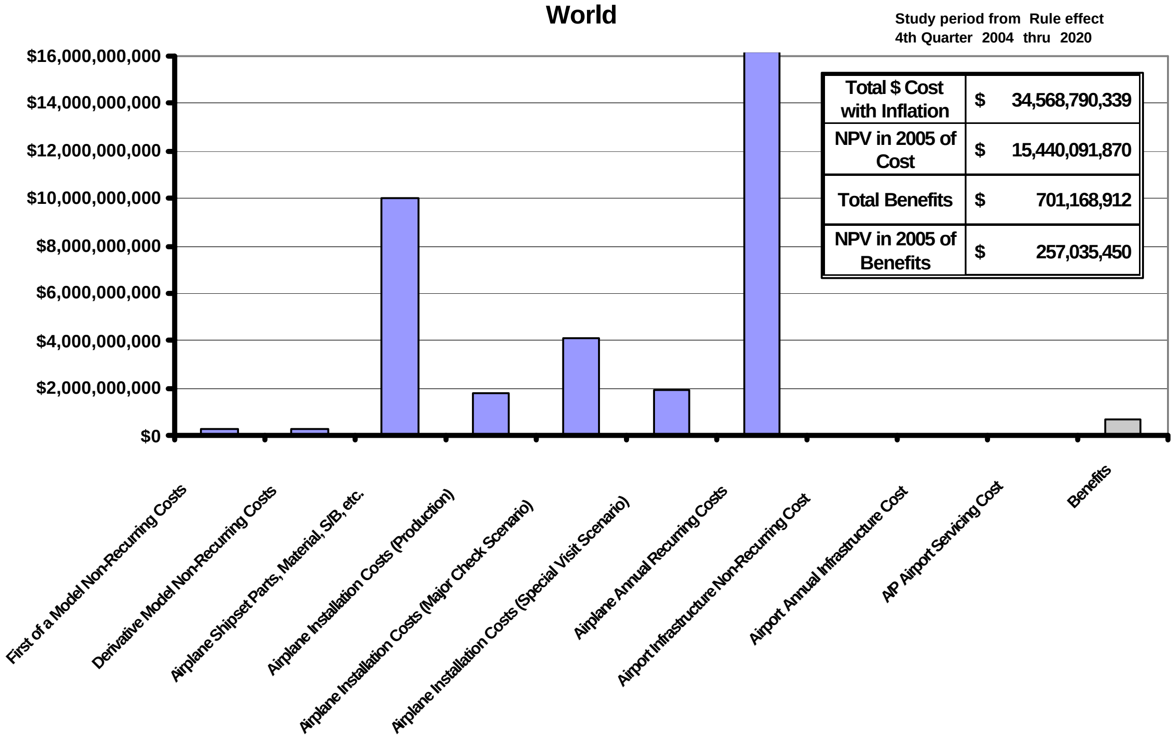

Figure 9-9. Scenario 14—Hybrid OBIGGS, Heated CWT Only, Large and Medium Transports, Cryogenic Systems, and Small Transports, PSA/Membrane Systems (World)

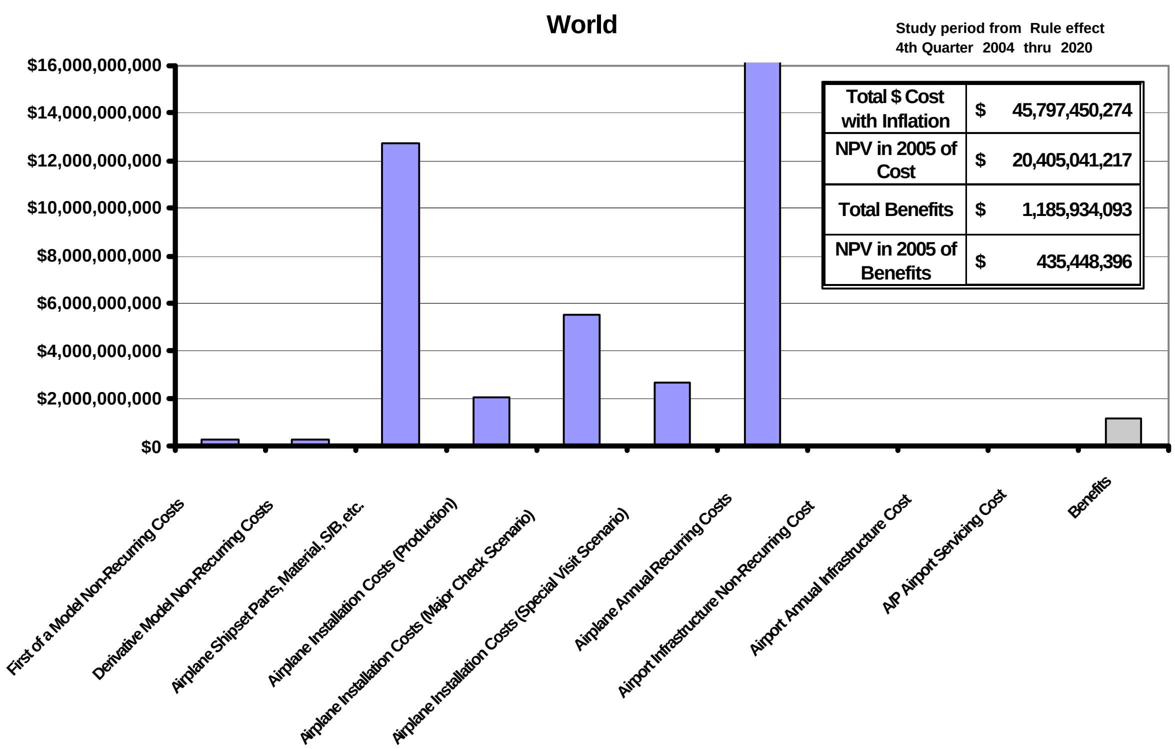

Figure 9-10. Scenario 15—Hybrid OBIGGS, All Tanks, Large and Medium Transports, Cryogenic Systems, and Small Transports, PSA/Membrane Systems (World)

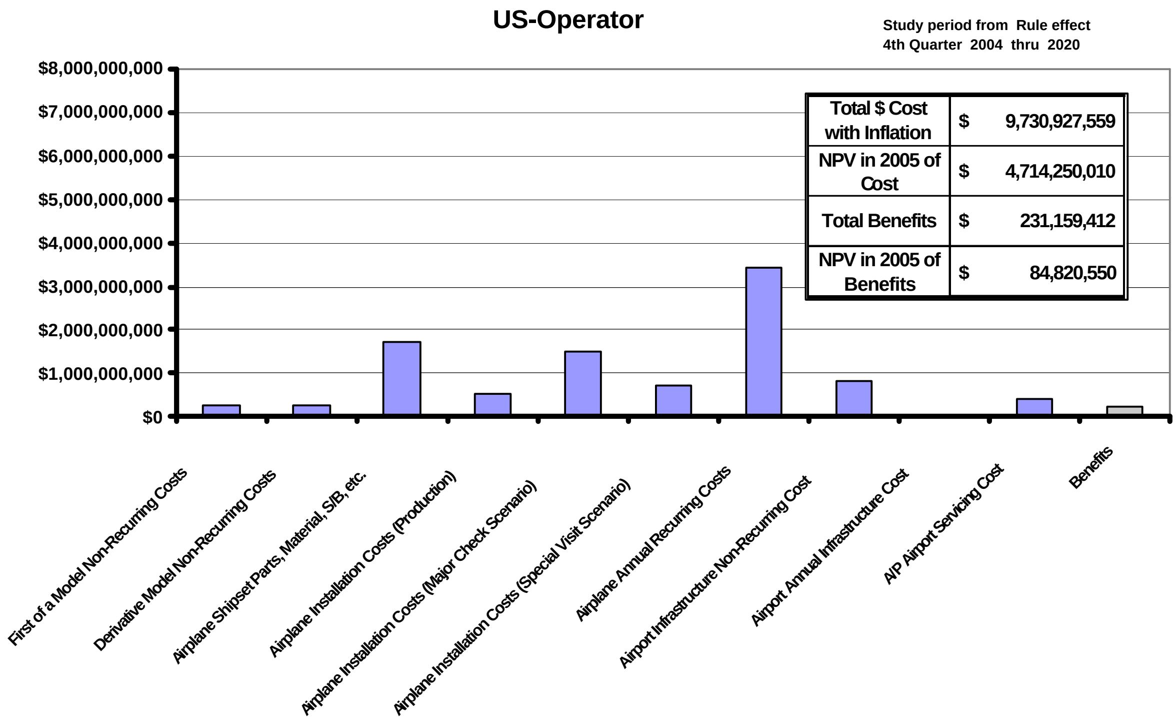

Figure 9-11. Scenario 3—Hybrid OBGI, Heated CWT Only, Large, Medium, and Small Transports, PSA/Membrane Systems (U.S.)

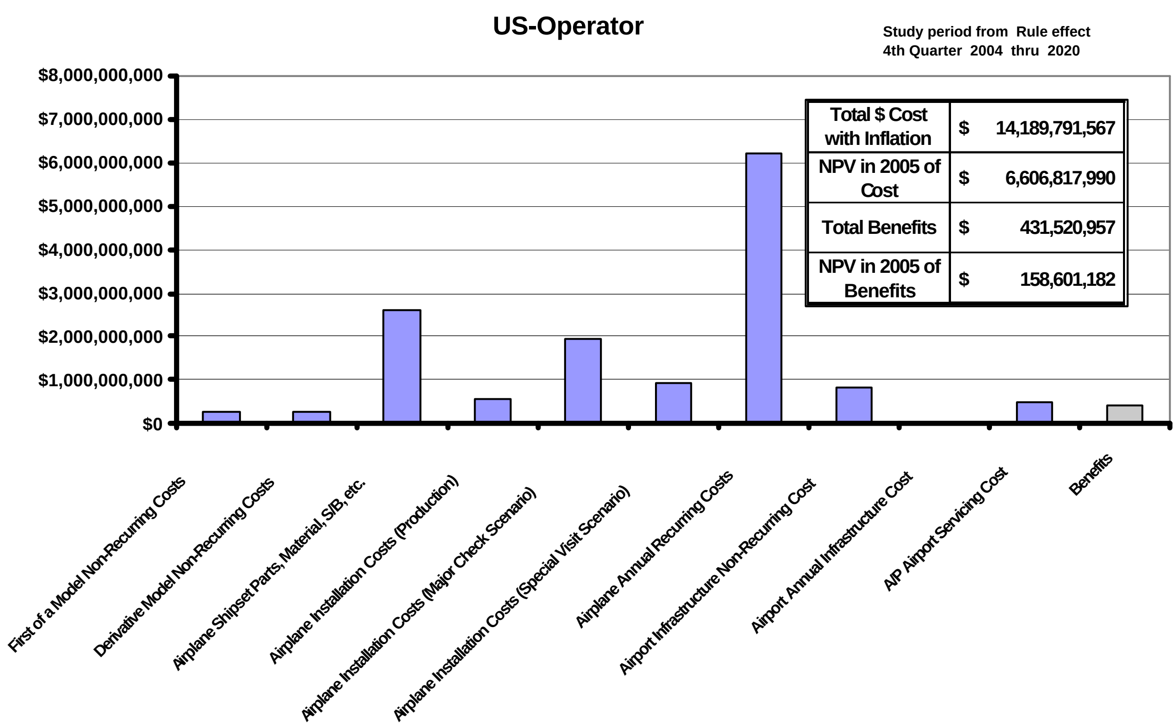

Figure 9-12. Scenario 4—Hybrid OBGI, All Fuselage Tanks, Large, Medium, and Small Transports, PSA/Membrane Systems (U.S.)

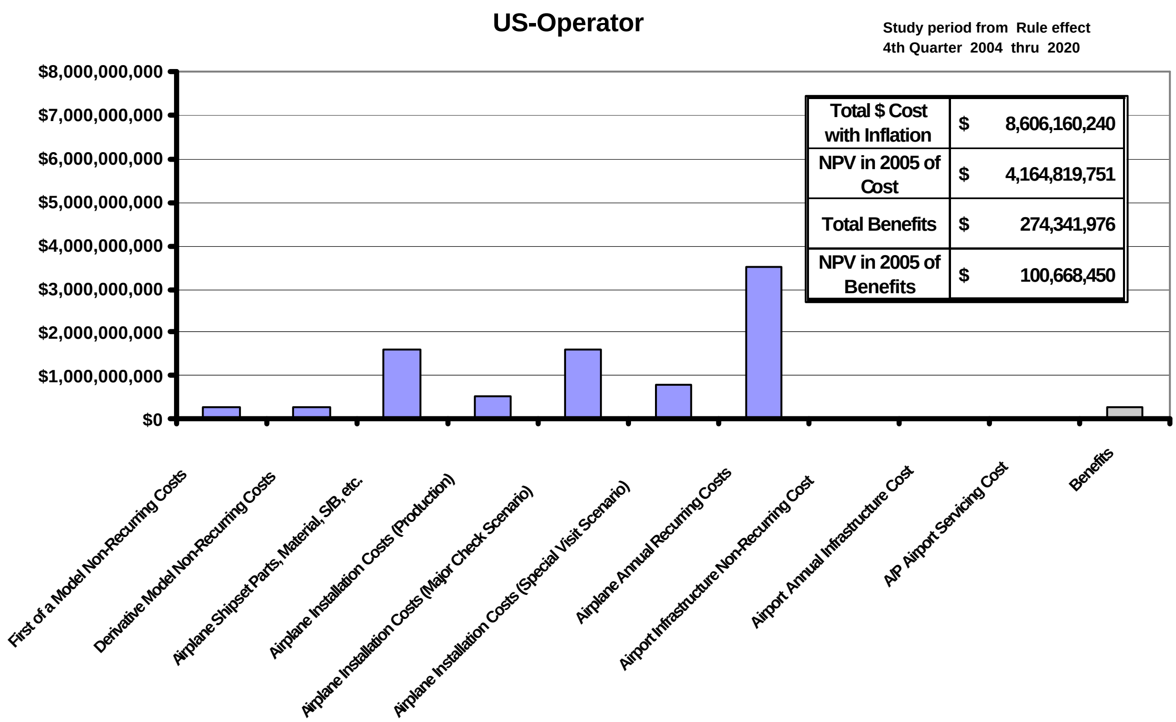

Figure 9-13. Scenario 7—Hybrid OBIGGS, Heated CWT Only, Large and Medium Transports, Membrane Systems, and Small Transports, PSA/Membrane Systems (U.S.)

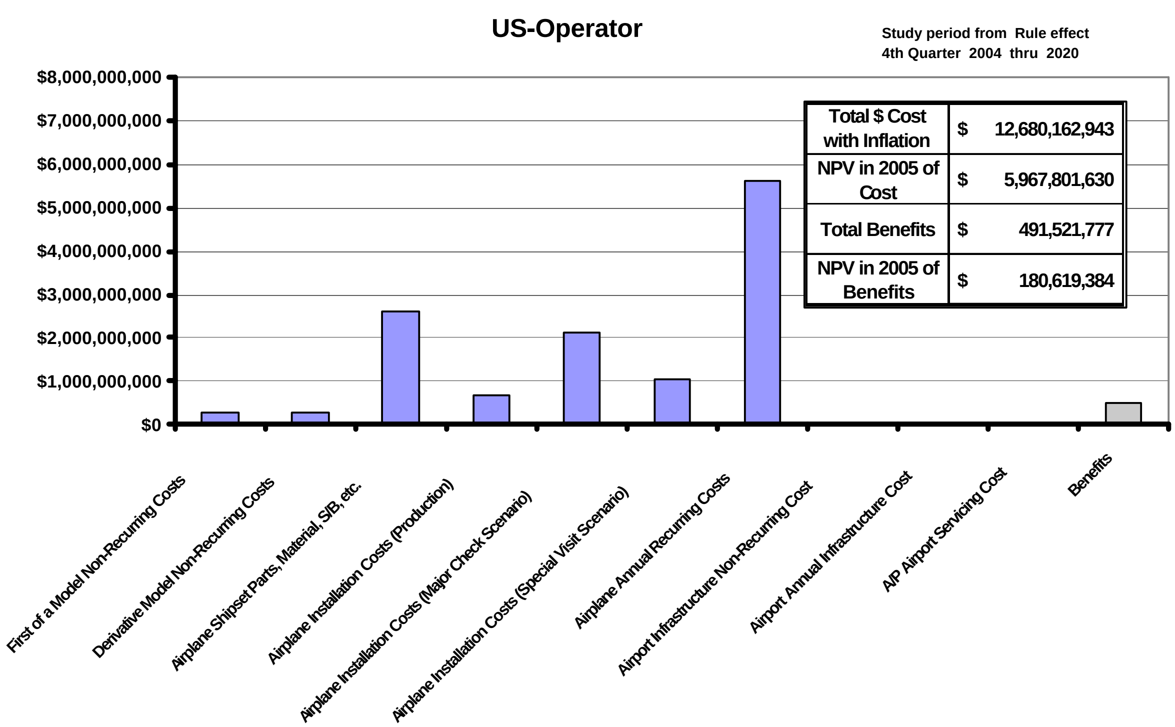

Figure 9-14. Scenario 9—Hybrid OBIGGS, All Tanks, Large and Medium Transports, Membrane Systems, and Small Transports, PSA/Membrane Systems (U.S.)

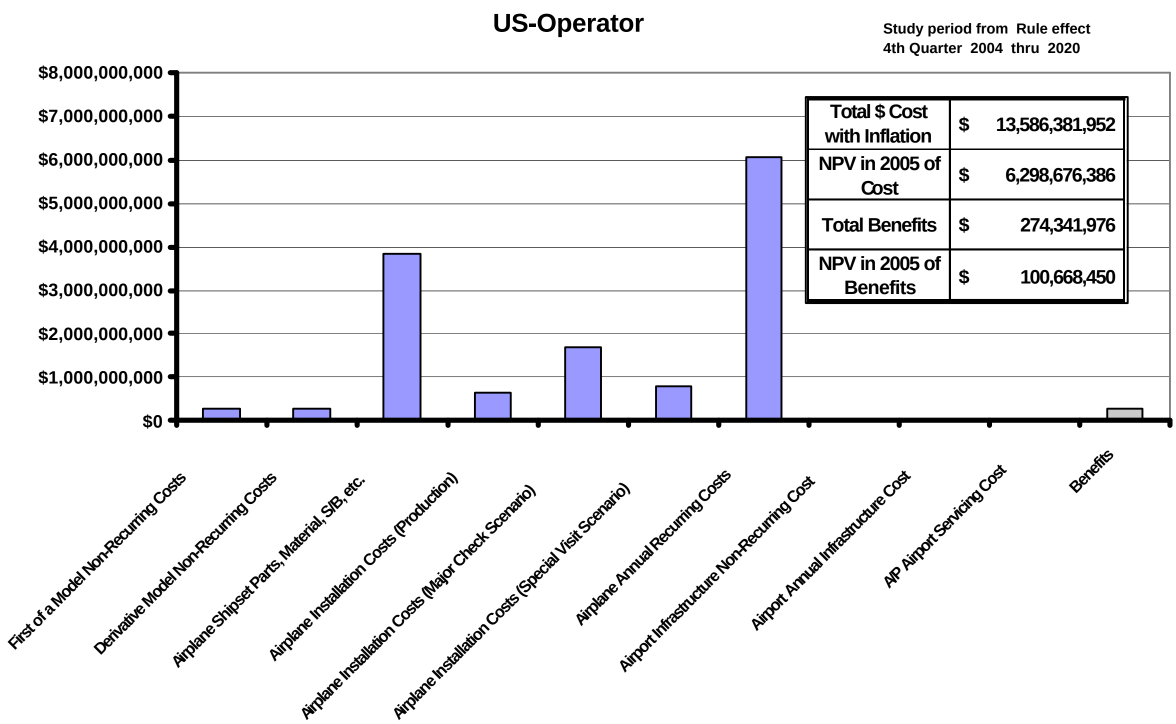

Figure 9-15. Scenario 14—Hybrid OBIGGS, Heated CWT Only, Large and Medium Transports, Cryogenic Systems, and Small Transports, PSA/Membrane Systems (U.S.)

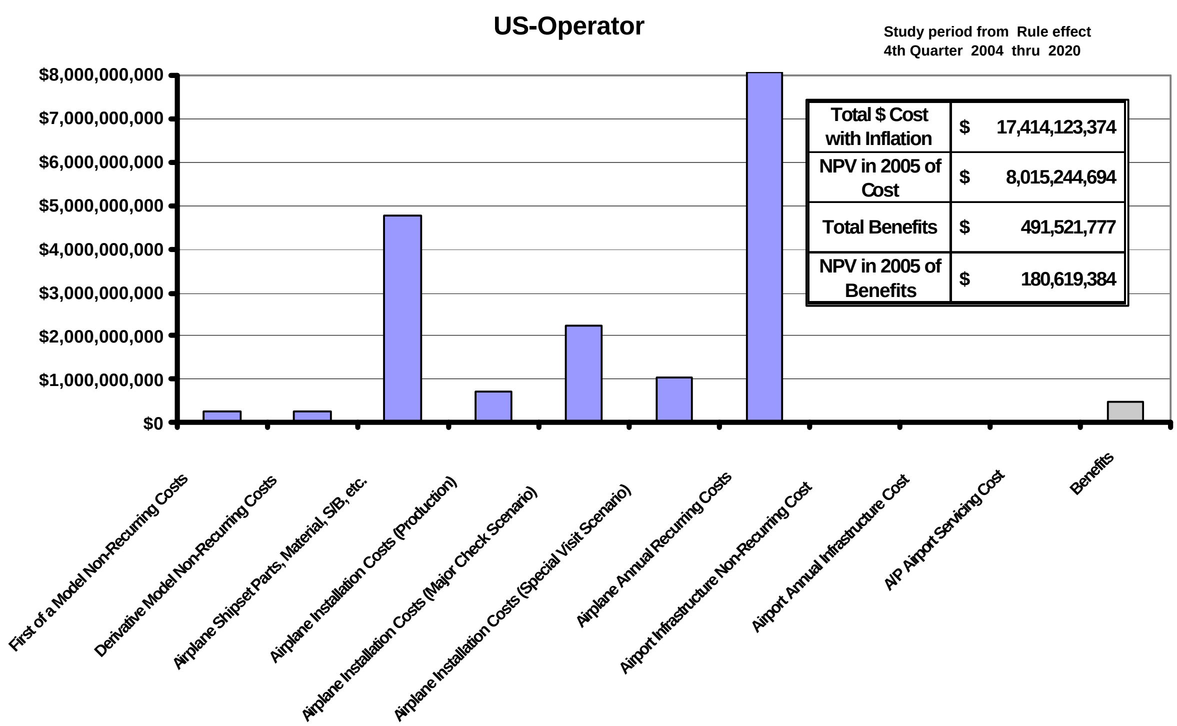

Figure 9-16. Scenario 15—Hybrid OBIGGS, All Tanks, Large and Medium Transports, Cryogenic Systems, and Small Transports, PSA/Membrane Systems (U.S.)

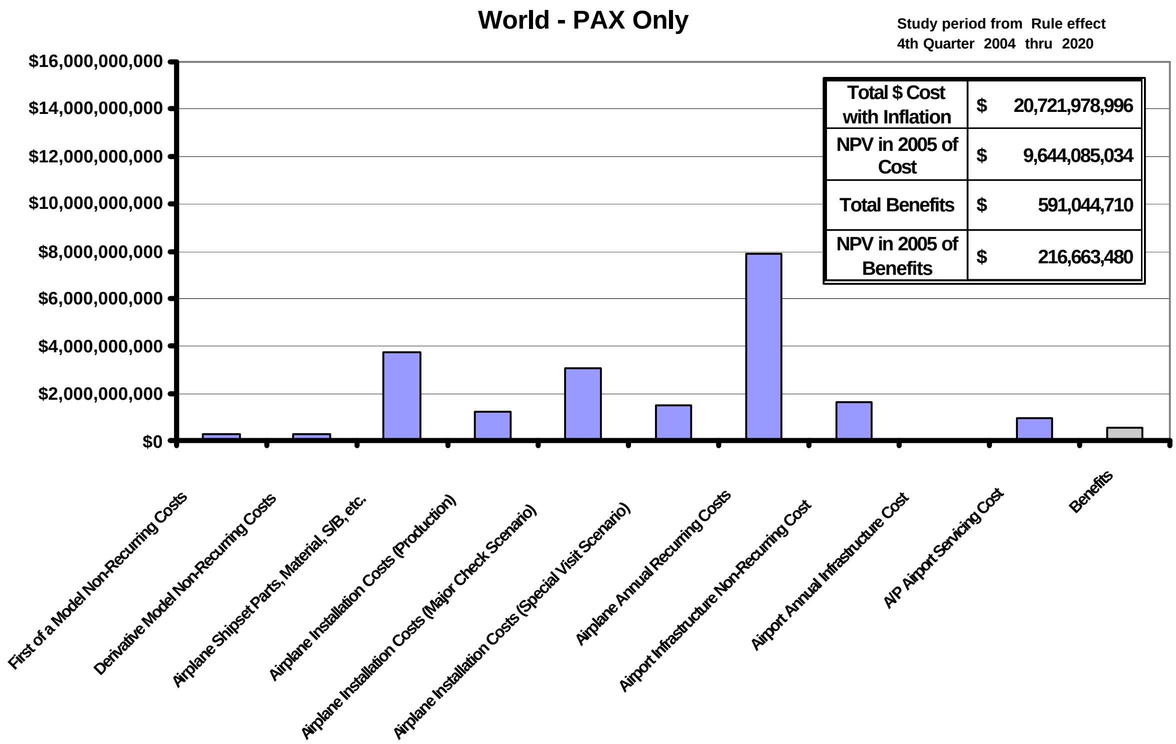

Figure 9-17. Scenario 3—Hybrid OBGI, Heated CWT Only, Large, Medium, and Small Transports, PSA/Membrane Systems (World, Passenger Only)

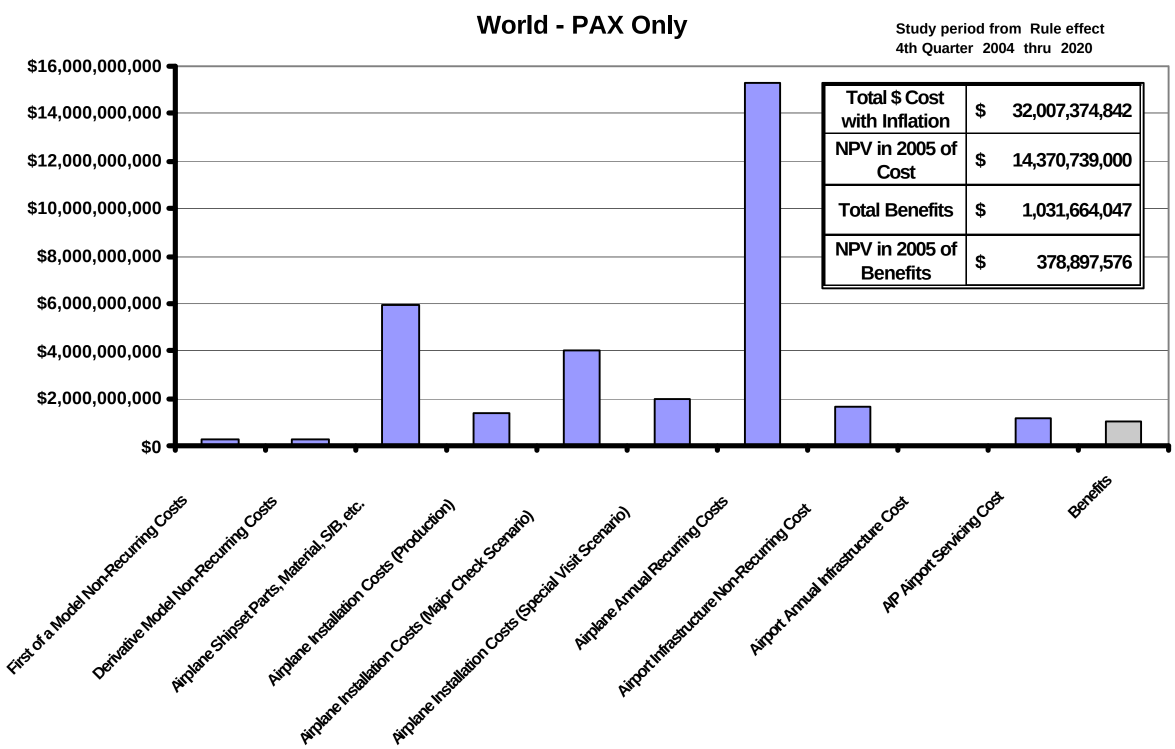

Figure 9-18. Scenario 4—Hybrid OBGI, All Fuselage Tanks, Large, Medium, and Small Transports, PSA/Membrane Systems (World, Passenger Only)

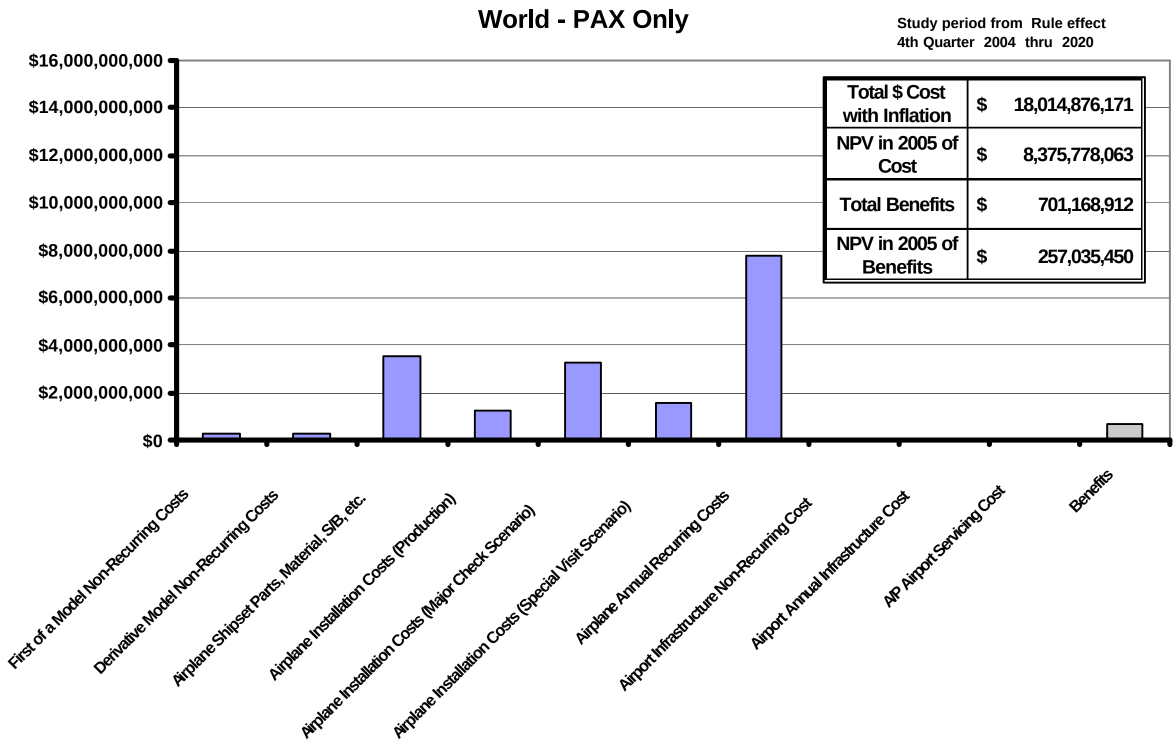

Figure 9-19. Scenario 7—Hybrid OBIGGS, Heated CWT Only, Large and Medium Transports, Membrane Systems, and Small Transports, PSA/Membrane Systems (World, Passenger Only)

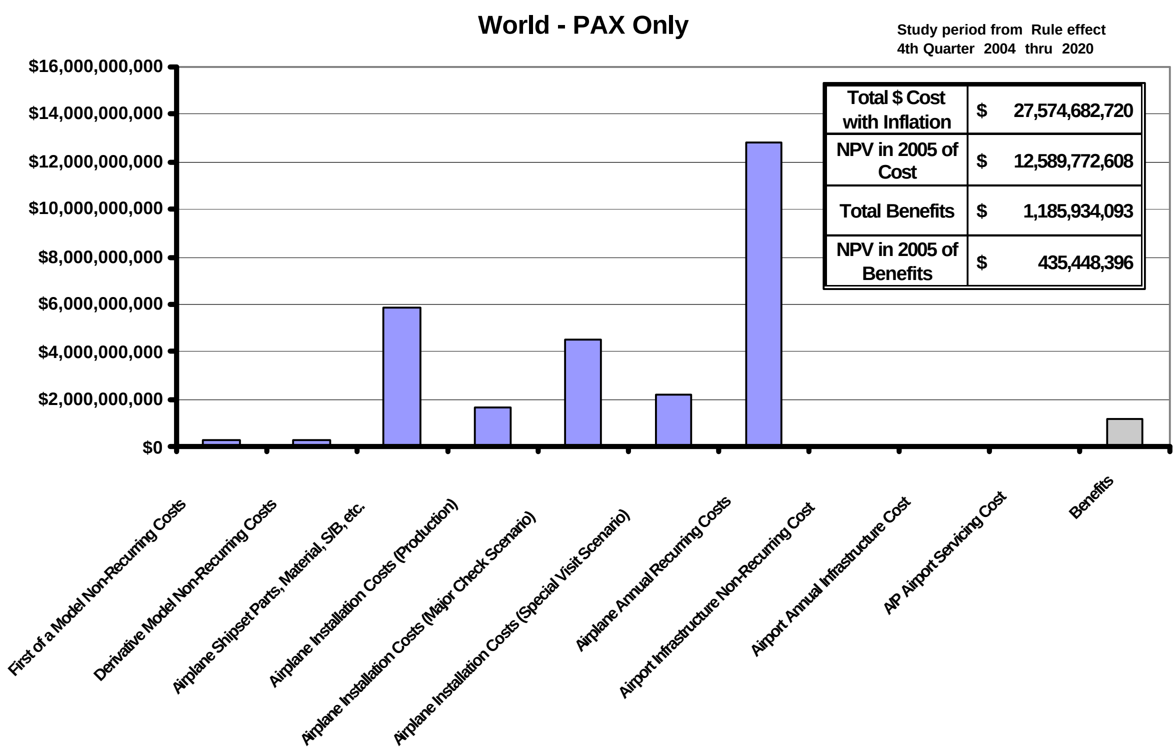

Figure 9-20. Scenario 9—Hybrid OBIGGS, All Tanks, Large and Medium Transports, Membrane Systems, and Small Transports, PSA/Membrane Systems (World, Passenger Only)

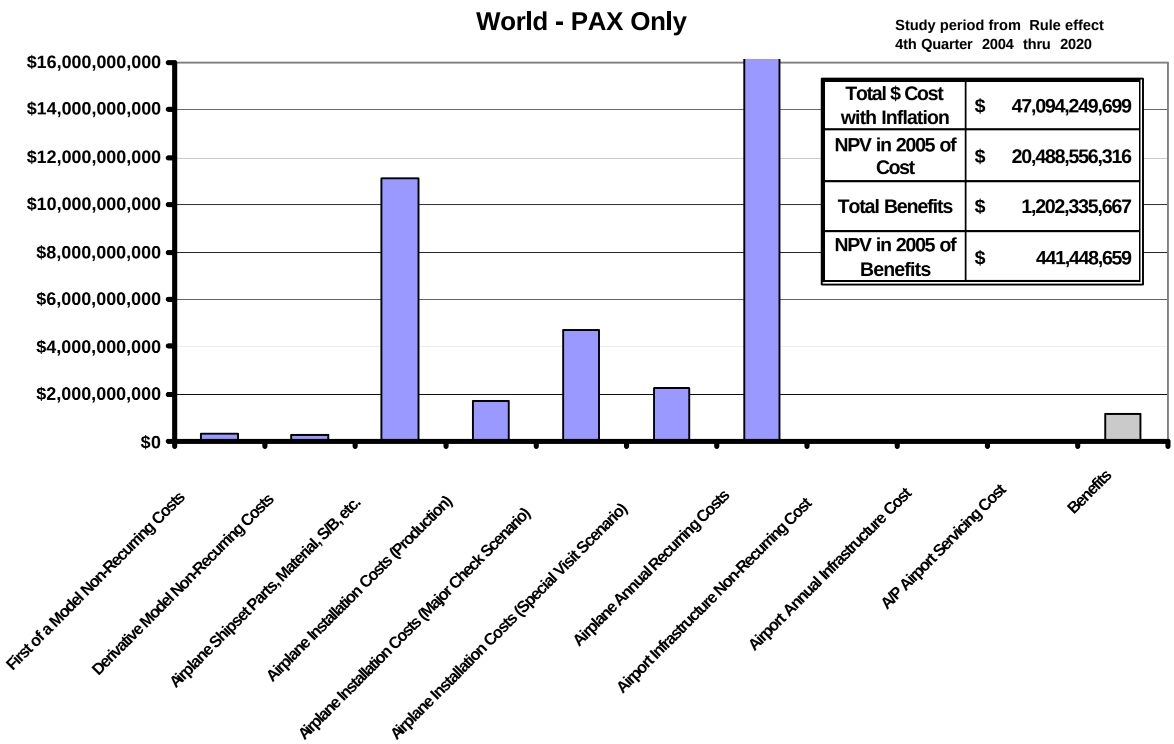

Figure 9-21. Scenario 13—OBIGGS, All Tanks, Large and Medium Transports, Cryogenic Systems, and Small Transports, PSA/Membrane Systems (World, Passenger Only)

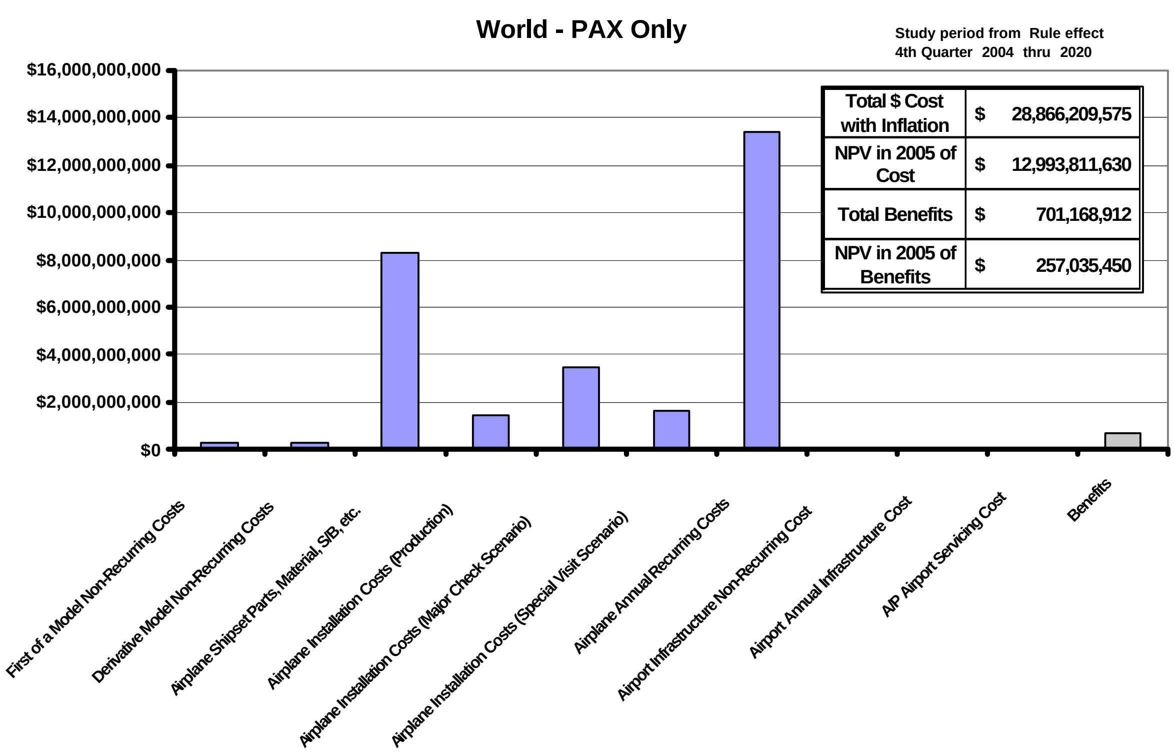

Figure 9-22. Scenario 14—Hybrid OBIGGS, Heated CWT Only, Large and Medium Transports, Cryogenic Systems, and Small Transports, PSA/Membrane Systems (World, Passenger Only)

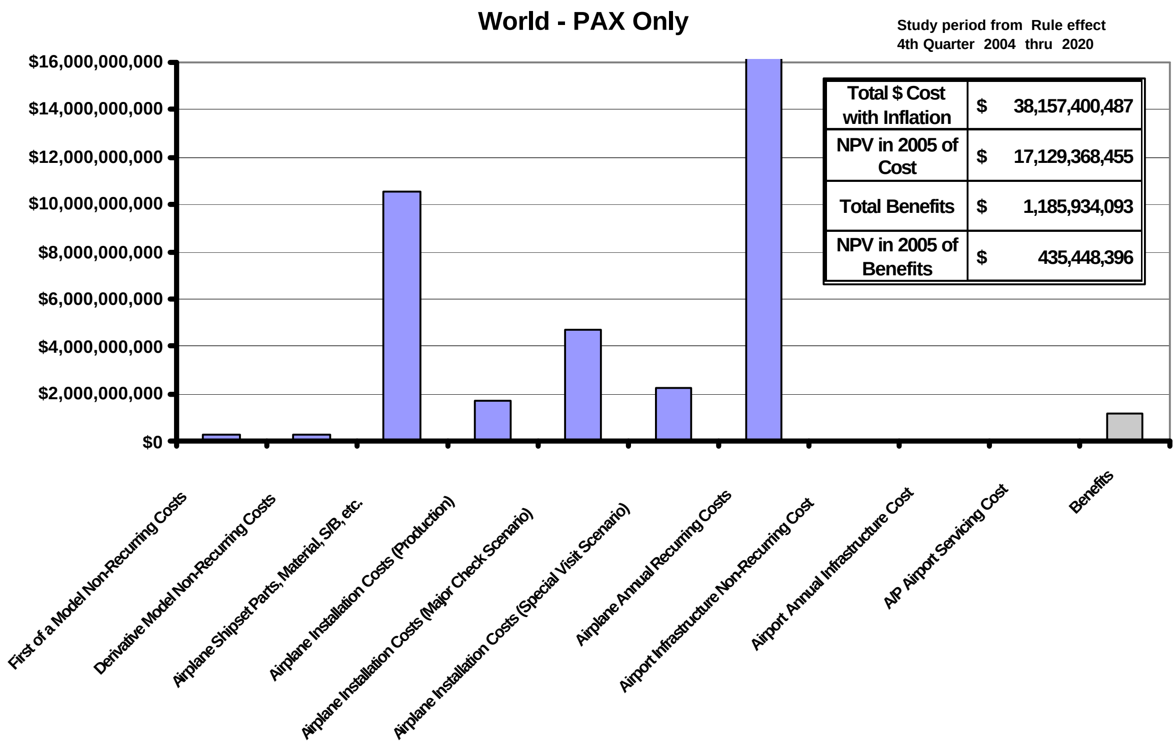

Figure 9-23. Scenario 15—Hybrid OBIGGS, All Tanks, Large and Medium Transports, Cryogenic Systems, and Small Transports, PSA/Membrane Systems (World, Passenger Only)

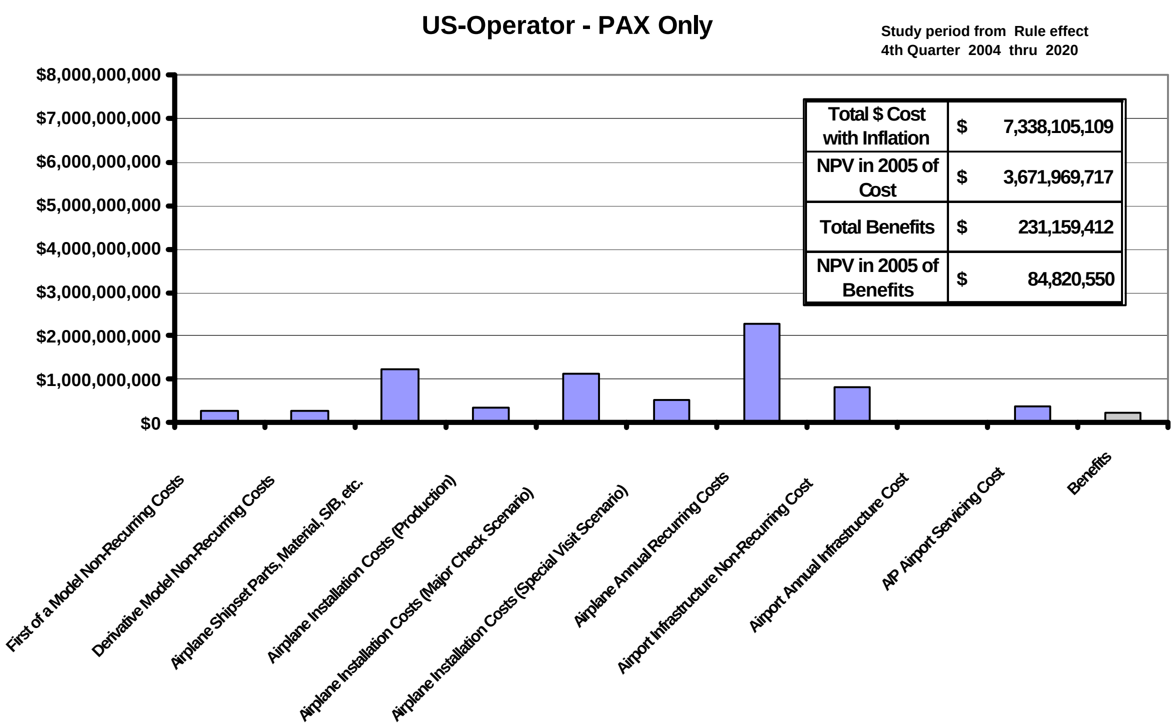

Figure 9-24. Scenario 3—Hybrid OBGI, Heated CWT Only, Large, Medium, Small Transports, PSA/Membrane Systems (U.S., Passenger Only)

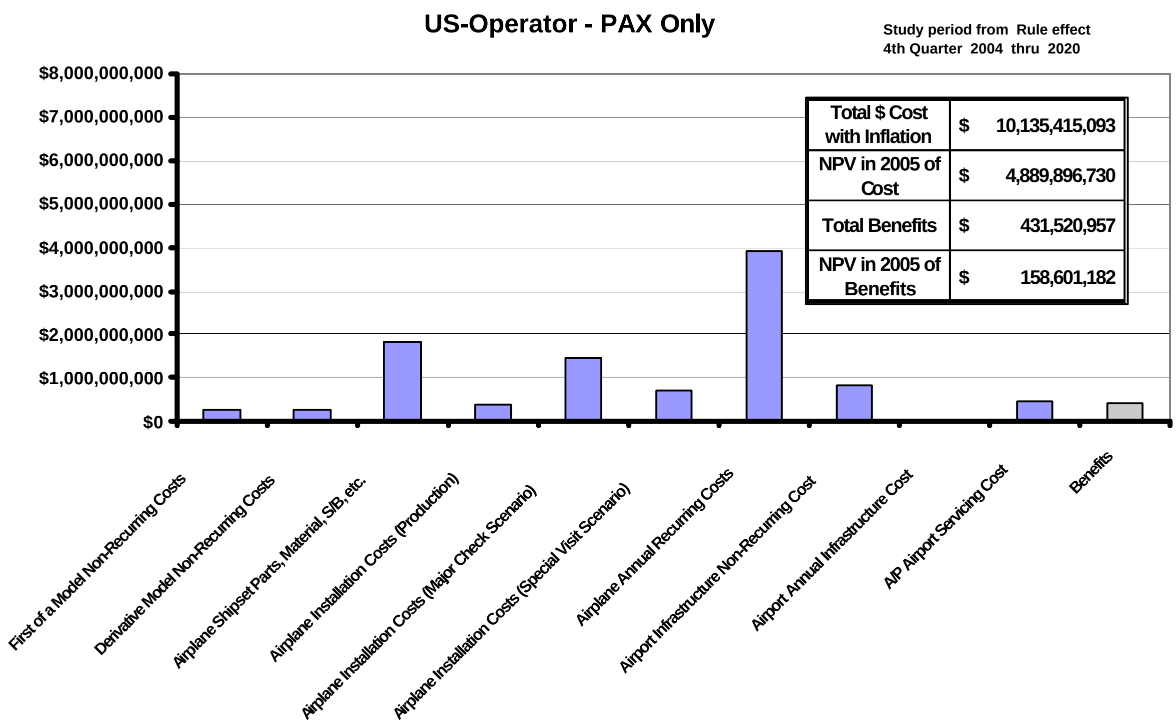

Figure 9-25. Scenario 4—Hybrid OBGI, All Fuselage Tanks, Large, Medium, Small Transports, PSA/Membrane Systems (U.S., Passenger Only)

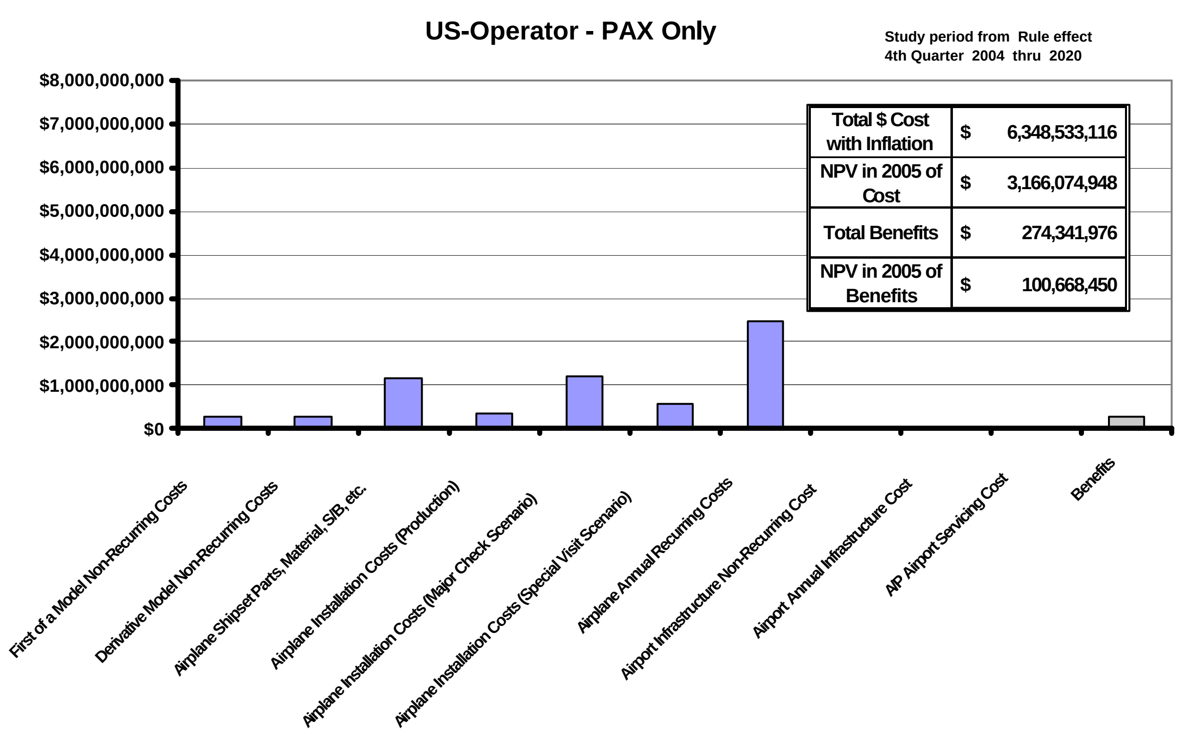

Figure 9-26. Scenario 7—Hybrid OBIGGS, Heated CWT Only, Large and Medium Transports, Membrane Systems, and Small Transports, PSA/Membrane Systems (U.S., Passenger Only)

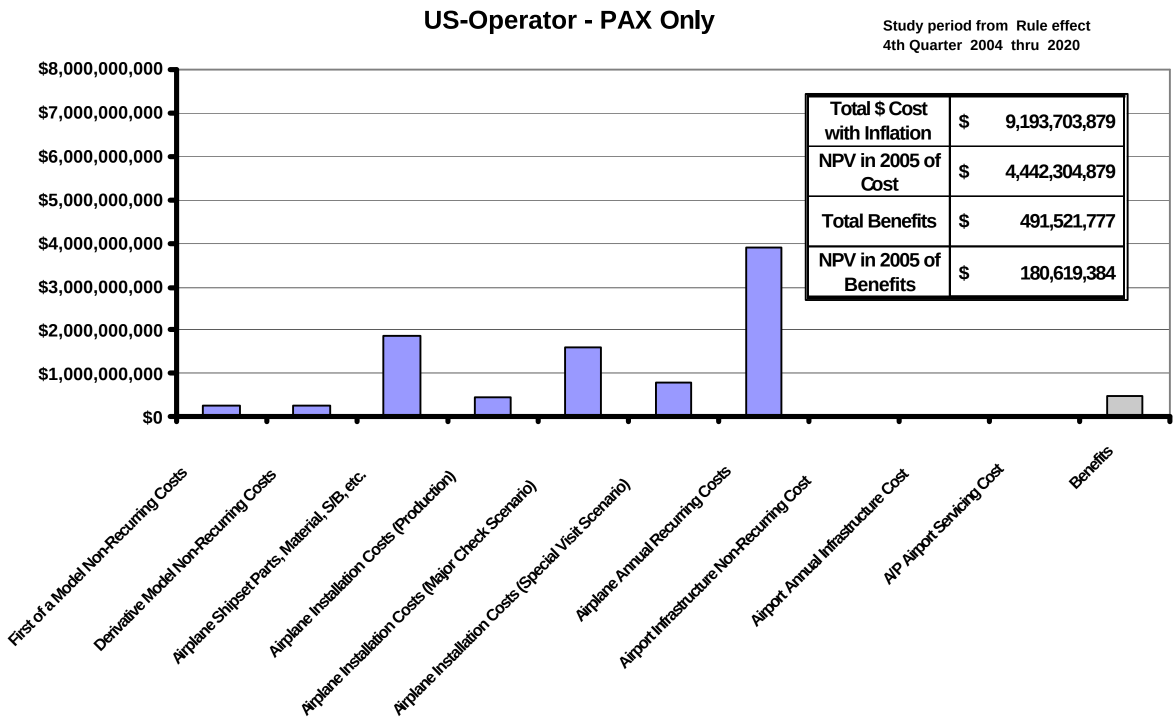

Figure 9-27. Scenario 9—Hybrid OBIGGS, All Tanks, Large and Medium Transports, Membrane Systems, and Small Transports, PSA/Membrane Systems (U.S., Passenger Only)

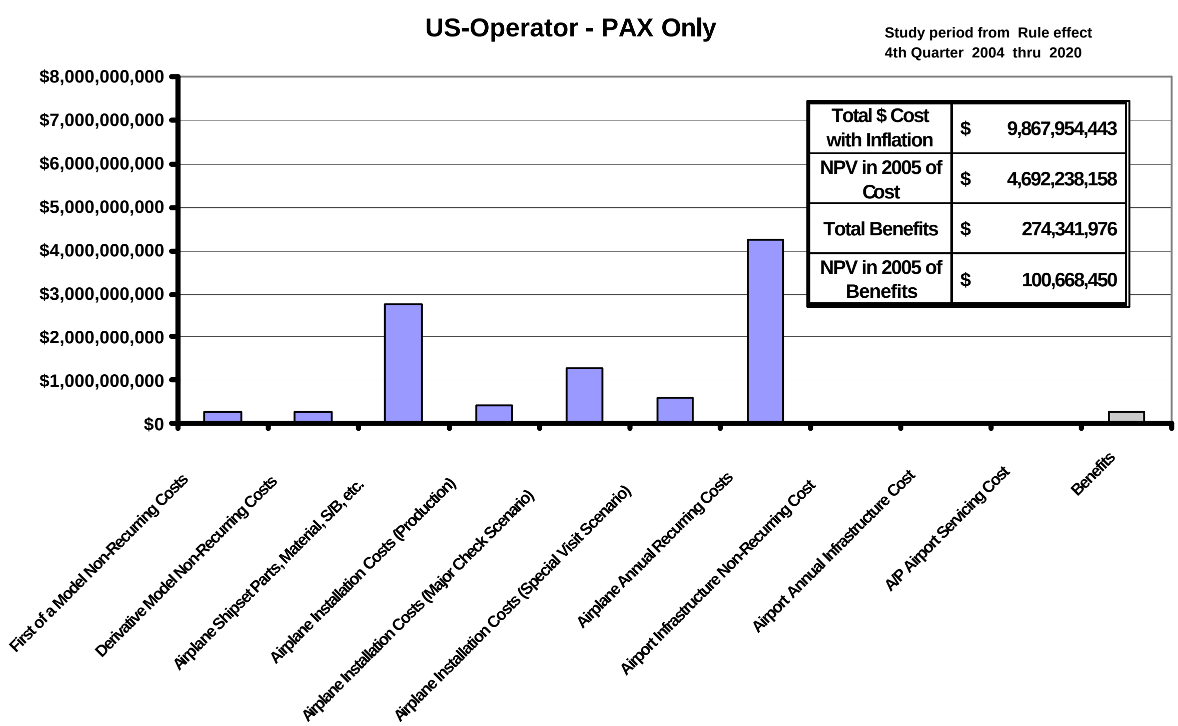

Figure 9-28. Scenario 14—Hybrid OBIGGS, Heated CWT Only, Large and Medium Transports, Cryogenic Systems, and Small Transports, PSA/Membrane Systems (U.S., Passenger Only)

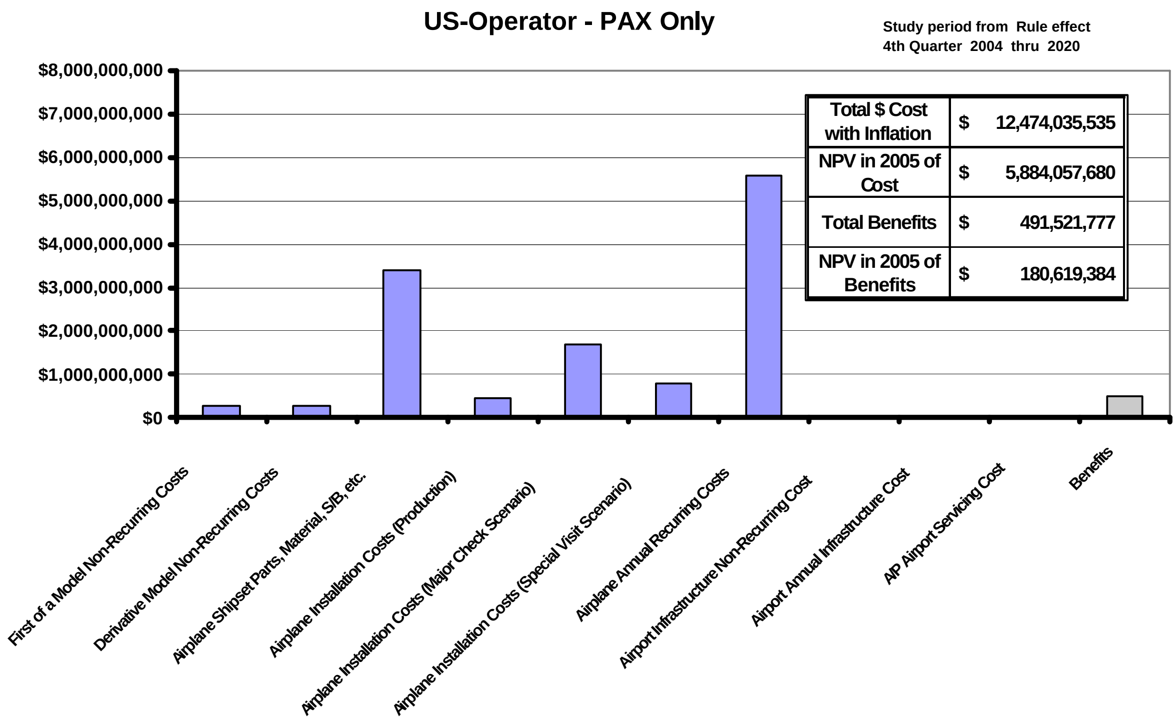

Figure 9-29. Scenario 15—Hybrid OBIGGS, All Tanks, Large and Medium Transports, Cryogenic Systems, and Small Transports, PSA/Membrane Systems (U.S., Passenger Only)

9.8 PROS AND CONS OF SYSTEM DESIGN CONCEPT

<u>*Pros of the Hybrid OBGIS*</u>

a. The hybrid OBGIS provides a reduction in total flammability exposure comparable to that of GBI.
b. The hybrid OBGIS potentially reduces corrosion and condensation in the fuel tanks, depending on where and how the operator uses the system.

<u>*Cons of the Hybrid OBGIS*</u>

a. The hybrid OBGIS is almost as large as the full OBGIS.
b. The cost of components (only a part of the total system cost) far exceeds the potential benefit.
c. Additional cost is incurred because extra fuel is burned as a result of the weight of the system plus the added aerodynamic drag caused by its inlet and exhaust ports.
d. The airplane's center of gravity may be adversely affected by the system's location in some airplane models, which will also cause a fuel penalty.
e. Compressor and fan noise may have to be damped, depending on local noise regulations.

<u>*Pros of the Hybrid OBIGGS*</u>

a. The hybrid OBIGGS provides a reduction in total flammability exposure comparable to that of GBI.
b. It is the smallest and least expensive of all the onboard design concepts.
c. The hybrid OBIGGS potentially reduces corrosion and condensation in the fuel tanks, depending on how the operator uses the system.

Cons of the Hybrid OBIGGS

a. The cost of components (which is just one component of the total system cost) far exceeds the potential benefit.
b. Additional cost is incurred because extra fuel is burned as a result of the weight of the system plus the added aerodynamic drag caused by its inlet and exhaust ports.
c. The airplane's center of gravity may be adversely affected by the system's location in some airplane models, which will also cause a fuel penalty.
d. Compressor and fan noise may have to be damped, depending on local noise standards.

9.9 MAJOR ISSUES AND RESOLUTIONS ASSOCIATED WITH CONCEPT

The issues and resolutions for these hybrids are similar to those of their full-sized counterparts, except that each is smaller than the full-sized version. See figure 9-30 for the hybrid OBGIS and figure 9-31 for the hybrid OBIGGS.

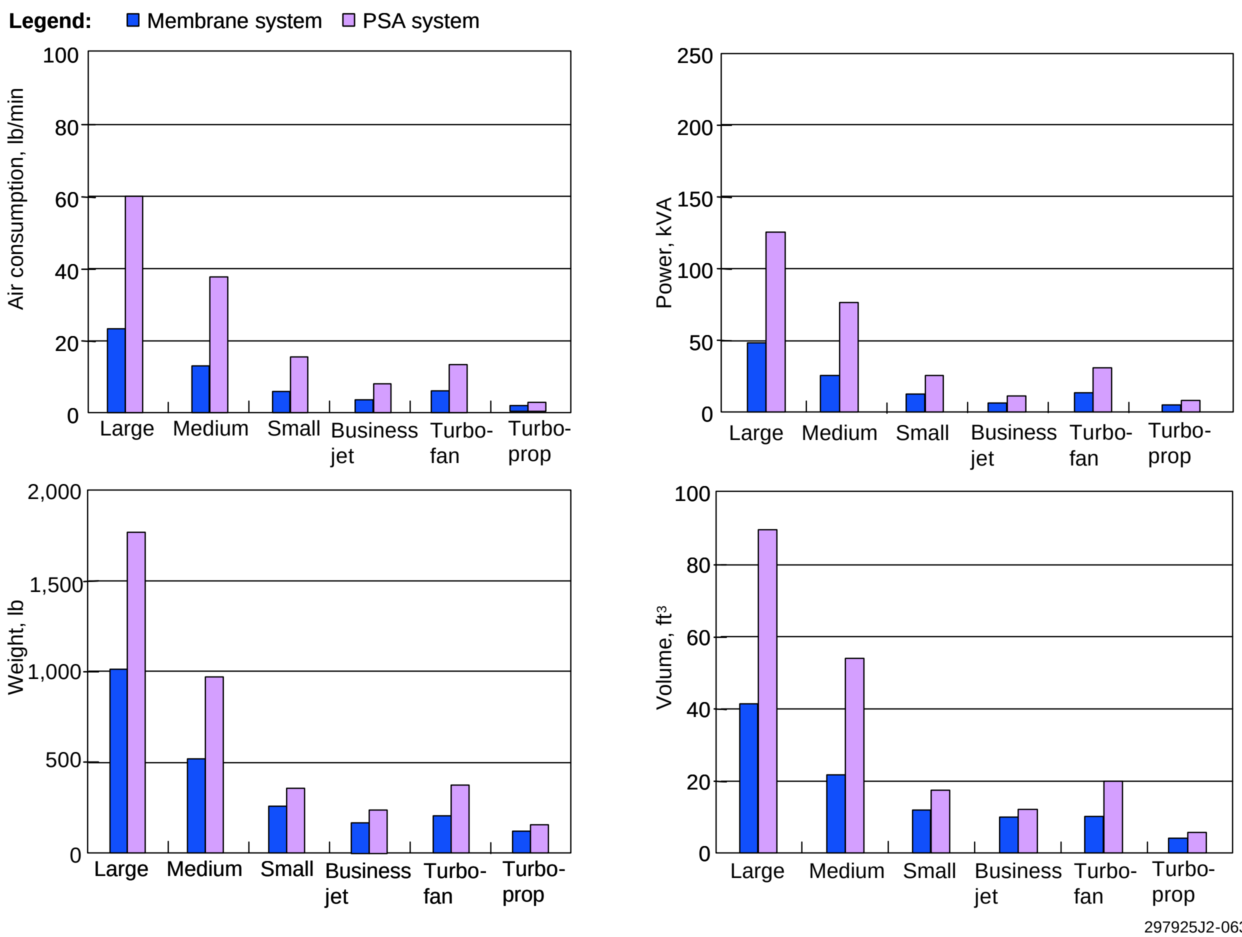

Figure 9-30. Hybrid OBGIS Installation Issues

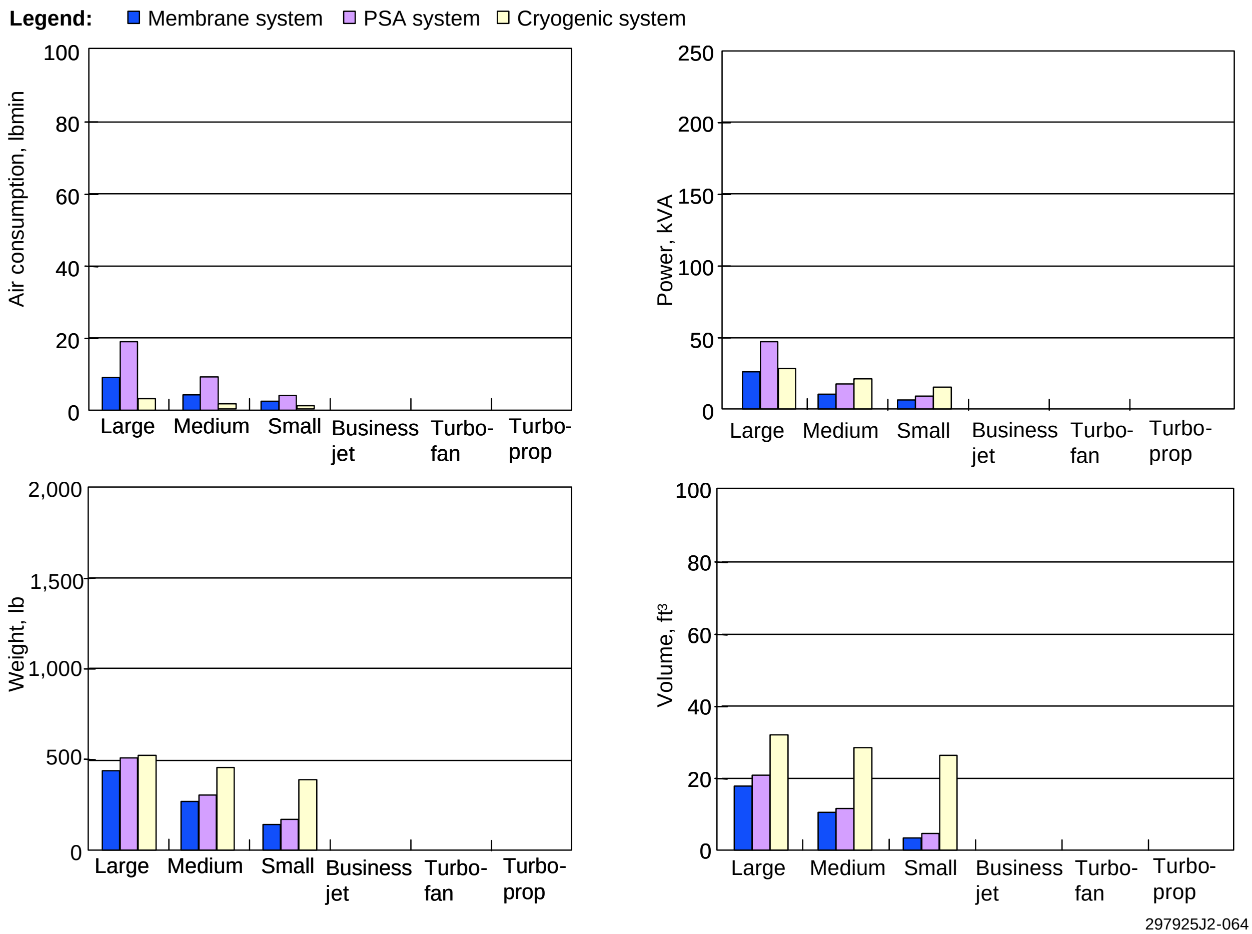

Figure 9-31. Hybrid OBIGGS Installation Issues

9.10 CONCLUSIONS

The hybrid OBGIS does not offer significant benefit for the extra certification effort required to operate it during taxi-in. Therefore, the FTIHWG does not recommend this concept.

The hybrid OBIGGS offers the flammability exposure of a GBIS, with a small and relatively inexpensive onboard system. However, its cost still far exceeds the potential benefit. Therefore, the FTIHWG does not recommend this concept.

10.0
Airline O&M